IMPROVED ULTRASOUND PROBE

Field of the Invention

The present invention relates to ultrasound probes, and more particularly, to an improved ultrasound probe that provides a simplified, low mass and reliable fixed connection between an ultrasound transducer array and signal cable that are interconnectable to an imaging system.

Background of the Invention

Known ultrasound imaging probe arrangements typically include a multi-conductor signal cable, one end of which is connected to an imaging system (e.g. comprising a signal processor and display monitor), and the other end of which is indirectly connected to an ultrasound transducer array. In response to an imaging system drive signal the ultrasound transducer array transmits acoustic waves into and receives echo pulses from a region of interest (ROI) to yield an image signal. In turn, the image signal is utilized by the imaging system to form an image of the ROI.

In some approaches, the indirect interconnection between the signal cable and ultrasound transducer array is established by a transitional device, e.g. a flexible printed circuit or printed circuit board). See e.g. U.S. Patent Nos. 6,100,626. Such transitional devices not only add expense and complexity, but also limit the maneuverability and reliability of the ultrasound probes.

Summary of the Invention

A primary objective of the present invention is to provide an ultrasound probe having reduced componentry.

A related objective of the present invention is to provide an ultrasound probe with reduced complexity.

A further related objective of the present invention is to provide an ultrasound probe with reduced assembly requirements.

Yet another related objective of the present invention is to provide an ultrasound probe having reduced material and production costs.

Additional broad objectives of the present invention are to provide an ultrasound probe having reduced bulk, and enhanced maneuverability and reliability.

One or more of the above objectives and additional advantages are realized by the ultrasound probe comprising the present invention. The inventive ultrasound probe includes a support member, a signal cable comprising a plurality of electrically conductive members (e.g. conductive wires), and an ultrasound transducer array supportably interconnected to a first side of the support member, wherein the ultrasound transducer array comprises a plurality of transducer elements electrically and fixedly interconnected to different ones of the electrically conductive members at the first side of the support member. As will become apparent, the inventive ultrasound probe may facilitate or otherwise provide a direct electrical connection between the electrically conductive members and transducer elements thereof.

In one aspect of the invention, distal end portions of the plurality of electrically conductive members are separately and at least partially embedded within and extend through the support member to the first side thereof along spaced-apart paths. To enhance compactness, the electrically conductive members may be positioned to follow substantially parallel paths through the support member. For example, the electrically conductive members may enter the support member on a second side that opposes the first side and follow substantially parallel and linear paths therebetween.

To facilitate embedded positioning of the electrically conductive members, a plurality of openings, or channels, may be defined in the support member. Such openings may be sized to engageably (e.g. conformally) receive the electrically conductive members therethrough. In one approach, the openings may be defined (e.g. via laser drilling) to extend from the first side to a second side that opposes the first side. In another approach, a separate channel for each of the electrically conductive members may extend into the support member (e.g. a plurality of parallel, cut grooves) from a third side thereof (e.g. the third side being orthogonal to the first and second sides). In yet another arrangement, to facilitate production, the support member may comprise first and second support members that are adjoined (e.g. bonded) with the plurality of electrically conductive members captured therebetween. In such arrangement, one or both of the first and second support members may be provided with channels (e.g. cut-out grooves) along the adjoining surface(s).

In another aspect of the invention, the support member may advantageously comprise at least one acoustic dampening material for dampening incident acoustic waves, and thereby isolate the ultrasound transducer array for enhanced imaging.

More particularly, the acoustic dampening material absorbs acoustic waves traveling in the rearward direction, thereby reducing undesired artifacts in image signals provided by the ultrasound transducer array. The acoustic dampening material may be selected to have an acoustic dampening index, or attenuation factor, of at least 1dB/cm MHz, and more preferably at least 5dB/cm MHz. By way of particular example, for medical imaging applications the acoustic dampening material may preferably have an acoustic dampening index of at least 15dB/cm MHz. For enhanced dampening, the acoustic dampening material may be provided to surround, and thereby completely embed the distal end portions of the electrically conductive members along the length thereof.

The first side of the support member may comprise a plurality of separated portions, wherein different ones of the electrically conductive members extend entirely through each of the separated portions. In one approach, the first side of the support member may be diced to define the separated portions. As may be appreciated, the above-noted plurality of transducer elements may be supportably interconnected to different ones of the separated portions of the support member.

In this regard, and in one embodiment of the present invention, the ultrasound transducer array may be defined by a piezoelectric layer. By way of example, the piezoelectric layer may comprise a ceramic-based material. Optionally, the ultrasound transducer array may be further defined by at least one electrically conductive signal layer interconnected to and between a first side of the piezoelectric layer and the first side of the support member. Further, an electrically conductive ground layer may be interconnected to a second side of the piezoelectric layer in opposing relation to said first side of the support member. Such ground layer may be selected to further provide

a degree of acoustic impedance matching (i.e. between the piezoelectric layer and the region of interest (ROI) to be imaged in a given application). In this regard, one or more additional acoustic matching layers may be interconnected to the ground layer (e.g. on the side facing the ROI), wherein for a given application the acoustic impedance of the piezoelectric layer may be even better matched to the acoustic impedance of the ROI to be imaged.

The piezoelectric layer and electrically conductive layer(s) interconnected thereto may each comprise an aligned, common plurality of separated portions that define a one-dimensional array, (e.g. a single row or column) or two-dimensional array (e.g. multiple rows and columns) of the transducer elements. In one approach, the piezoelectric layer and optional electrically conductive signal layer(s) may be contemporaneously diced to define the plurality of separated portions. In another approach, the piezoelectric layer, first electrically conductive ground layer, optional acoustic matching layers, and the optional electrically conductive signal layer(s) may be contemporaneously diced to define the plurality of separated portions. In either case, the dicing operation may be completed in tandem with dicing of the first side of the support member.

As may be appreciated, the distal ends of the electrically conductive members, together with the optional, separated portions of the electrically conductive signal layer(s), define signal electrodes of each of the transducer elements. In turn, the electrically conductive ground layer may define either a common ground member or, if provided in separated portions, separate ground members of the plurality of transducer elements. Further in this regard, the electrically conductive ground layer may be

electrically interconnected to a separate ground cable or to an electrically conductive ground member that further comprises the signal cable.

Of note, a primary portion of each of the electrically conductive members comprising the signal cable may extend proximally from the support member and be fixedly interconnected to a coupler of the signal cable at a proximal end thereof, wherein the primary portions of the electrically conductive members comprise at least a majority of the total continuous length of the electrically conductive members from a proximal end to a distal end of the signal cable. Additionally, the signal cable may be of a flexible construction. In this regard, the ultrasound probe may be continuously flexible from the support member to the proximal end of the signal cable.

In one approach, the electrically conductive members of the signal cable are separately interconnected in coincidental orientations to a non-conductive carrier. As noted, a coupler may be fixedly interconnected at the proximal end of the signal cable for selective interconnection and disconnection of the ultrasound probe to an ultrasound system, (e.g. either directly or via selective interconnection with a compatible coupler comprising one or more additional signal cable(s)). As may be appreciated, such coupler(s) may comprise separate electrically conductive members for each of the plurality of electrically conductive members.

In yet a further aspect of the present invention, a plurality of signal cables may be utilized in the inventive ultrasound probe, wherein distal ends of the plurality of electrically conductive members comprising each of the signal cables are separately embedded in and extend through one or an adjoined plurality of support member(s). For example, a plurality of signal cables may be positioned in a side-by-side

arrangement and interconnected to an extended one-dimensional ultrasound transducer array. In another embodiment, the distal ends of a plurality of signal cables may be disposed in a stacked arrangement and interconnected to a two-dimensional ultrasound transducer array. In this embodiment, the support member may comprise a plurality of members, wherein the distal end portions of the electrically conductive members comprising each signal cable are captured between different pairs of said members. Such one-dimensional and two-dimensional arrangements may employ the various other features noted above.

Numerous additional features and attendant advantages of the present invention will be apparent to those skilled in the art upon consideration of the further description that follows.

Brief Description of the Drawings

Fig. 1 is a perspective, partial cutaway view of one embodiment of an ultrasound probe comprising the present invention.

Fig. 2 is a perspective, partial cutaway view of another embodiment of an ultrasound probe comprising the present invention.

Fig. 3 is a perspective, partial cutaway view of an additional ultrasound probe embodiment comprising the present invention.

Fig. 4 is another perspective, partial cutaway view of the ultrasound probe embodiment shown in Fig. 3.

Fig. 5 illustrates the ultrasound probe embodiment of Fig. 1 interconnected to an exemplary imaging system.

Detailed Description of the Invention

Fig. 1 illustrates one embodiment of an ultrasound probe **10** comprising a plurality of signal cables **20** whose distal ends are electrically and fixedly interconnected in a side-by side arrangement to a one-dimensional ultrasound transducer array **30**. The distal ends of the signal cables **20** and ultrasound transducer array **30** are oriented to define a "forward-looking" arrangement. In this regard, the ultrasound probe **10** further includes a support member **40** for supportably receiving the distal ends of a plurality of signal lines **22** comprising each of the signal cables **20** and for supporting the ultrasound transducer array **30** on a forward-facing side thereof.

More particularly, distal end portions of each of the signal lines **22** may be separately embedded within and extend through the support member **40** from a rearward-facing side to the forward-facing side thereof. To accommodate signal lines 22, a plurality of openings may be defined through the support member **40** in corresponding spaced relation to the spacing between, or pitch of, the signal lines **22** of signal cables **20**. The signal lines **22** may each include an outer insulating layer **22a** that has been removed from an embedded distal end portion of an electrically conductive wire **22b**.

In one arrangement, the support member **40** may be defined by adjoined (e.g. bonded) portions of first and second support members **42** and **44**, respectively, that capture the distal ends of signal lines **22** therebetween. The first support member **42** and/or second support member **44** may be provided with parallel channels (e.g. cut-out grooves) for receiving signal lines **22** therethrough.

In this regard, the support member **40** may advantageously comprise a molded, acoustic dampening material. The acoustic dampening material may be selected to provide a predetermined degree of acoustic dampening tailored for the particular intended application of ultrasound probe **10**. By way of example, the support member **40** may comprise an epoxy-based dampening material having an acoustic dampening index, or attenuation factor, of at least 1 dB/cm MHz, and more preferably at least 5 dB/cm MHz. Further, the support member **40** may comprise two or more adjoined layers, e.g. a rearward layer comprising a first epoxy-based material (e.g. a composite comprising a relatively soft polymer embedded in a relatively hard matrix) that is relatively rigid and has a relatively high acoustic dampening index (e.g. at least 40 dB/cm MHz), and a forward layer bonded to the rearward layer and comprising a second epoxy-based material (e.g. a pure two-part epoxy resin) that has a lower acoustic dampening capability but enhanced bonding capabilities.

The ultrasound transducer array **30** may comprise a piezoelectric layer **32** interconnected (e.g. bonded) to support member **40.** In one arrangement, the piezoelectric layer **32** may comprise a ceramic-based material such as PZT (i.e. lead zirconate titanate). Optionally, an electrically conductive signal layer **46** may be interconnected (e.g. bonded) to a forward-facing side of support member **40**. In one arrangement, conductive signal layer **46** may be defined by gold-plating. Further, an electrically conductive signal layer **34** may be optionally disposed (e.g. sputter deposited) on a rearward-facing side of piezoelectric layer **32** and interconnected (e.g. bonded) to a forward facing side of support member **40** or conductive signal layer **42** if provided.

An electrically conductive ground layer **36** may also be interconnected (e.g. bonded) to a forward-facing side of the piezoelectric layer **32.** In addition to being electrically conductive, ground layer **36** may be selected to yield a degree of acoustic impedance matching between the piezoelectric layer **32** and an imaging region of interest (ROI) for a given application. By way of example, conductive ground layer **36** may comprise an epoxy-based material having metal particles mixed therewith. In other arrangements, ground layer **36** may be defined by a metal foil, metal mesh or metallized plastic substrate. Optionally, a further acoustic matching layer **38** may be interconnected (e.g. bonded) to a forward-facing surface of the ground layer **36**. By way of example, matching layer **38** may comprise an electrically nonconductive material selected to yield an additional degree of acoustic impedance matching between the piezoelectric layer **32** and the ROI for a given application. For example, in a typical medical application, a tissue ROI may have an acoustic impedance of about 1.5 MRayl, and the piezoelectric layer **32,** ground layer **36** and matching layer **38** may be provided to have acoustic impedances of about 20-30 MRayl, 5-15 MRayl and 2-5 MRayl.

As shown, electrically conductive ground layer **36** and piezoelectric layer **32**, as well as the optional layers **38**, **34** and **42** if provided, may each comprise an aligned, common plurality of separated portions that define a one-dimensional array or row, of transducer elements of ultrasound transducer array **30**. Correspondingly, a shallow-depth of the forward-facing side of support member **40**, may comprise a corresponding, aligned plurality of same-sized, separated portions. The various separated portions noted above may be separately or contemporaneously defined. For example, in one approach, the ultrasound transducer array **30**, forward-facing side of support member

40, and various electrically conductive layers interconnected thereto may be cut, or diced, contemporaneously. In turn, an electrically non-conductive material **60** (e.g. a room-temperature-vulcanizing (RTV) rubber) may be provided (e.g. via vacuum impregnation) into the cut-out regions to electrically isolate and physically adjoin the separated portions.

As illustrated, different ones of the electrically conductive wires **22b** extend through each of the separated portions at the forward-facing side of support member **40** to directly contact the ultrasound transducer array **30**. The distal ends of wires **22b**, together with the separated portions of conductive signal layer **46** and/or conductive signal layer **34** if provided, define signal electrodes for the transducers elements comprising the ultrasound transducer array **30.** Preferably, the combined thickness of conductive signal layer **46** and conductive signal layer **34** is between about 1,000 angstroms and, 20,000 angstroms. Further, the separated portions of conductive ground layer **36** defines ground electrodes for the transducer elements comprising the ultrasound transducer array **30.** Preferably the thickness of conductive ground layer **36** is between about .2 λ (wavelength) and .3 λ (wavelength).

Further in this regard, the electrically conductive ground layer **36** is electrically connected to an electrically conductive layer **24** of each of the signal cables **20**. More particularly, the electrically conductive layer **24** may be of a flexible construction (e.g. a copper foil) and readily wrapped around a portion of support member **40** to physically contact a portion of the electrically conductive ground layer **36** that extends around the top and/or bottom surfaces of piezoelectric layer **32** and a portion of support member **40.** In one example, electrically conductive ground layer **36** may be interconnected to

piezoelectric layer **32** and support member **40**. Certainly, numerous other approaches may be utilized to establish electrical contact between the electrically conductive ground layer **36** and electrically conductive layers **24** of signal cables **20**.

To isolate the optional electrically conductive signal layers **36** and **24** from the electrically conductive ground layer **36**, isolation channels **50** that extend across the width of either or both of the support member **40** and piezoelectric layer **32** may be provided. As shown, the isolation channels **50** may be combinatively defined by aligned channels (e.g. cut-out grooves) that extend across the width of both the support member **40** and piezoelectric layer **32**, and that are of a depth that exceeds the thickness of optional conductive signal layers **42** and **34**, respectively.

As may be appreciated, the ultrasound probe **10** shown in Fig. 1 is of a maneuverable, relatively simple and reliable construction. In this regard, a product marketed under the name MICROFLAT by W.L. Gore & Associates, Inc. may be readily utilized for signal cables **20**. As shown, each MICROFLAT signal cable **20** includes signal lines **22** physically interconnected to a carrier defined by first and second base layers **26** and **28** (e.g. comprising polyimide), with the above-noted flexible, electrically conductive layer **24** disposed therebetween.

Fig. 2 illustrates another embodiment of an ultrasound probe **100** comprising a plurality of signal cables **120** whose distal ends are electrically and fixedly interconnected in a stacked arrangement to a two-dimensional ultrasound transducer array **130**. Again, the distal ends of the plurality of signal cables **120** and ultrasound transducer array **130** are oriented to define a “forward-looking” arrangement. In this regard, the ultrasound probe **100** further includes a support member **140** for supportably

receiving the distal ends of a plurality of signal lines **122** comprising each of the signal cables **120** and for supporting the ultrasound transducer array **130** on a forward-facing side thereof. In this embodiment, a strain-relief member **110** may be interconnected (e.g. bonded) about the plurality of signal cables **120** and to a rearward-facing side of support member **140**. By way of example, strain-relief member **110** may comprise a resilient material (e.g. a polymer-based material).

Distal end portions of each of the signal lines **122** may be separately embedded within and extend through the support member **140** from a rearward facing side to the forward-facing side thereof. The signal lines **122** may each include an outer insulating layer **122a** that has been removed from an embedded distal end portion of an electrically conductive wire **122b.**

As illustrated, the support member **140** may be defined by a plurality of adjoined (e.g. epoxy bonded) sets of first and second support members **142** and **144,** respectively, wherein each given set receives the signal lines **122** of a corresponding different one of said plurality of signal cables **120** therebetween. The first and/or second support members **142** and **144** of each set may be provided with parallel channels (e.g. cut-out) for receiving signal lines **122** therethrough. Such channels may be provided in corresponding spaced relation to the spacing between, or pitch of, the signal lines **122** of each given signal cable **120**. In another arrangement, the support member **140** may be defined by a plurality of adjoined, commonly-shaped support members, wherein the signal lines **122** of a different one of the plurality of signal cables **120** are located between a different adjoining pair of support members. In such arrangement, parallel channels may be provided on one or both sides of each support

member in corresponding spaced relation to the pitch of the signal lines **122** of each given cable **120**.

Again, the support member **140** may comprise a molded acoustic dampening material. As with ultrasound probe **10**, the acoustic dampening material may be selected to provide a predetermined degree of acoustic dampening for the intended application. Further, the support member **140** of ultrasound probe **110** may comprise a plurality of layers comprising different acoustic dampening materials.

The ultrasound transducer array **130** may comprise a piezoelectric layer **132** interconnected (e.g. bonded) to support member **140.** In one arrangement, the piezoelectric layer **132** may comprise a ceramic-based material (e.g. PZT). An optional electrically conductive signal layer (not shown) may be interconnected to a forward-facing side of the support member **140** (e.g. a gold-plated layer). Further, an optional electrically conductive signal layer **134** may be interconnected (e.g. sputter deposited) to a rearward-facing side of piezoelectric layer **132** and interconnected (e.g. bonded) to a forward-facing side of support member **140** or an electrically conductive signal layer if provided thereupon.

An electrically conductive-backed sheet **136** may be interconnected (e.g. via epoxy bonding) to a forward-facing side of the piezoelectric layer **132.** By way of example, the conductive-backed sheet **136** may comprise a plastic substrate (e.g. mylar) with an electrically-conductive ground layer of metalization provided on the side of the plastic substrate that faces piezoelectric layer **132.** While not shown, a duel electrically conductive and acoustic impedance matching layer may be interposed between the conductive-backed sheet **136** and piezoelectric layer **132** in order to better

match the acoustic impedance of the piezoelectric layer **132** to the imaging ROI of a given application.

The piezoelectric layer **132**, as well as the optional electrically signal conductive signal layer **134** may each comprise an aligned, common plurality of separated portions that define a two-dimensional array of transducer elements of ultrasound transducer array **130**. Correspondingly, a shallow-depth of a forward-facing side of the support member **140** may comprise a corresponding, aligned plurality of same-sized, separated portions. Again, the various separated portions may be separately or contemporaneously defined, e.g. the piezoelectric layer **132**, optional conductive signal layer **134**, and the forward facing side of support member **140** and optional conductive signal layer thereupon, may be cut or diced contemporaneously. In turn, an electrically non-conductive material **160** (e.g. RTV rubber) may be provided (e.g. via vacuum impregnation) into the cut-out regions between the separated portions so as to electrically isolate and physically adjoin the separated portions.

As shown, different ones of the electrically conductive wires **122b** extend through each of the separated portions at the forward-facing side of the support member **140** to directly contact array **130.** The distal ends of wires **122b**, together with the separated portions of the optional conductive signal layer **134** and optional conductive signal layer on support member **140**, define signal electrodes of the transducer elements comprising the ultrasound transducer array **130.** In this embodiment, the electrically conductive-backed sheet **136** defines a common ground electrode member for all of the transducer elements comprising the ultrasound transducer array **130.**

Further, in this regard, the electrically conductive-backed sheet **136** may be electrically connected to a ground conductor comprising a separate cable **170** (shown in phantom lines). For isolation purposes, isolation channels **150** may be provided. The cable member **170** may be of flexible construction and interconnected (e.g. bonded or soldered) to rear-facing side of support member **140**. In turn, the cable ground member **170** runs the entire length of signal cables **120**.

Again, the ultrasound probe **10** shown in Fig. 2 is of a maneuverable, relatively simple and reliable construction. In this regard, a product marketed under the name IMAGIN by W.L. Gore & Associates, Inc. may be readily utilized for each of the signal cables **120**. As illustrated, the IMAGIN signal cables **120** each include signal lines **122** physically interconnected by a webbing **124** (e.g. comprising a Teflon-based polymer). As may be appreciated, the webbing **124** and insulation layers **122a** of signal lines **122** may be integrally defined by a common material.

Figs. 3 and 4 illustrate an additional embodiment of an ultrasound probe **200** that is quite similar to the ultrasound probe **10** illustrated in Fig. 1. The ultrasound probe **200** comprises a plurality of signal cables **120** whose distal ends are connected in an offset, stacked fashion to a one-dimensional ultrasound transducer array **230** to define a "side-looking" arrangement. In this regard, the ultrasound probe **200** includes a support member **240** for supportably receiving the distal ends of a plurality of signal lines **222** comprising each of the signal cables **220** and for supporting the ultrasound transducer array **230** on a top side thereof.

The distal end portions of signal lines **222** may be embedded within and extend through the support member **240**. Again, a plurality of openings may be defined

through the support member **240** in corresponding spaced relation to the spacing between, or pitch of, the signal lines **222** of signal cables **220.** The signal lines **222** may each include an outer insulating layer **222a** that has been removed from an embedded distal end portion of an electrically conductive wire **222b.** Again, the support member **240** may be defined by adjoined first and second support members **242** and **244** respectively, and the first support member **242** and/or second support member **244** may be provided with parallel channels (e.g. cut-out) for receiving the distal ends of signal lines **222** therethrough. As shown, portions of signal cables **220** adjacent to the distal end portions thereof may be twisted 90° and bent, or folded, to an orthogonal orientation relative to the distal end portions. In order to maintain such positioning, outer support members **248** may be interconnected to support member **240** and an epoxy-based material **249** may be disposed between the outer support members **248** and in bonded engagement with the signal cables **220**.

Again, the support member **240** may comprise a molded acoustic dampening material. As with ultrasound probe **10**, the acoustic dampening material may be selected to provide a predetermined degree of acoustic dampening for the intended application. Further, the support member **240** may comprise a plurality of layers comprising different dampening materials.

The ultrasound transducer array **230** may comprise a piezoelectric layer **232** interconnected (e.g. bonded) to support member **240**. In one arrangement, the piezoelectric layer **232** may comprise a ceramic-based material (e.g. PZT). Optionally, an electrically conductive signal layer **246** may be interconnected (e.g. sputter deposited) to a top side of support member **240**. In one arrangement, conductive layer

246 may be defined by gold-plating. Further, an electrically conductive signal layer **234** maybe interconnected (e.g. bonded) to a bottom-facing side of piezoelectric layer **232** and top-facing side of support member **240** or conductive signal layer **242** if provided thereupon.

Electrically conductive ground layer **236** may also be interconnected (e.g. cast) to a top-facing side of piezoelectric layer **232**. Again, this layer may also serve as an acoustic matching layer. Optionally, a further acoustic matching layer **238** may be interconnected (e.g. bonded) to a top-facing surface of conductive ground layer **236.**

As shown, electrically conductive ground layer **236** and piezoelectric layer **232**, as well as the optional layers **238, 234** and **246** if provided, may each comprise an aligned, common plurality of separated portions that define a one-dimensional array, or row, of transducer elements of ultrasound transducer array **230.** Correspondingly, a shallow depth of the top-facing side of support member **240** may comprise a corresponding, aligned plurality of same-sized, separated portions. The various separated portions may be separately or contemporaneously defined. Again, in one approach the ultrasound transducer array **230,** and top-facing side of support member **240** may be cut, or diced, contemporaneously. In turn, an electrically non-conductive material **260** (e.g. RTV rubber) may be provided (e.g. via vacuum impregnation) into the cut-out regions to electrically isolate and physically interconnect the separated portions.

As illustrated, different ones of the electrically conductive wires **222b** extend through each of the separated portions at the top-facing side of support member **240** to directly contact array **230**. The distal ends of wires **222b**, together with the separated portions of conductive signal layer **246** and/or conductive signal layer **234** if provided,

define signal electrodes of the transducer elements comprising the ultrasound transducer array **230**. In turn, the separated portions of conductive ground layer **236** define ground connections of the transducer elements comprising ultrasound array **230**.

In the later regard, the electrically conductive ground layer **236** is electrically connected to electrically conductive ground layers **224** of each of the signal cables **220**. More particularly, conductive layer **236** is electrically interconnected to ground layers **224** via intermediate, electrically conductive members **237** (e.g. conductive foil fingers-only one shown) that extend from between base layers **226** or **228** of each of the signal cables **220** to contact the ground layer **236**. In the embodiment shown in Fig. 3 and 4, isolation channels **250** may be provided along the length of the probe **200** to isolate the conductive signal layers **246**, **234** from the ground layer **236**.

Ultrasound probe **200** may conveniently utilize the above-noted MICROFLAT product for signal cables **220**. The utilization of such cable yields a maneuverable ultrasound probe **200** that may be readily fabricated.

More generally, each of the ultrasound probe embodiments **10, 200** and **300** is adapted for simplified interface with an imaging system. For example, and as shown in Fig. 5, the signal cables **20** of ultrasound signal probe **10** may each be fixedly provided with a proximal end coupler **300** for plug-in interface with an imaging system **400** (e.g. comprising a signal processor and display). Optionally, intermediate couplers **310** may be provided at the proximal ends of signal cables **20** for ready interface with intermediate couplers **320** provided at the ends of additional signal cables **330**.

The above-described embodiments are not intended to limit the scope of the present invention as numerous modifications and extensions will be apparent to those

skilled in the art. For example, Litz wire or coaxial cable lines may be utilized in place of signal cables **20**, **120**, **220**. In the case of cable lines, an outer conductive sheathing of each cable line may be electrically interconnected via a common, conductive wire to a ground layer **36**, **136**, **236**. Further, capacitive micromachined ultrasound transducers (MUTS), may be used in place of ultrasound transducer arrays **30**, **130**, **330.**

Such modifications are merely exemplary of the range of equivalents that may be employed for the various features of the present invention as further defined by the claims which follow.